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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1 53(b))

Attorney Docket No.	004198.P011X
First Inventor or Application Identifier	Ron Nevo
Title	MULTIPLE WIRELESS COMMUNICATION PROTOCOL METHODS AND APPARATUSES INCLUDING QUALITY OF SERVICE
Express Mail Label No.	EL033433972US

jc811 U.S. PTO 09/557048 04/21/00

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

1. ☒ Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. ☒ Specification [Total Pages 36] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (*if filed*)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. ☒ Drawing(s) *(35 U.S.C. 113)* [Total Sheets 12]
4. Oath or Declaration [Total Pages 4]
   a. ☒ Newly executed (original copy)
   b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR §§ 1.63(d)(2) and 1.33(b).

NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. ☐ Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Copy
   b. ☐ Paper Copy (identical to computer copy)
   c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☒ Assignment Papers (cover sheet & document(s))
8. ☐ 37 C.F.R. § 3.73(b) Statement *(when there is an assignee)* ☒ Power of Attorney
9. ☐ English Translation Document *(if applicable)*
10. ☐ Information Disclosure Statement (IDS)/PTO - 1449 ☐ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. ☒ *Small Entity Statement(s) ☐ Statement filed in prior application, Status still proper and desired
14. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. ☐ Other: .....

16. **If a CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No: 09/439,946, 09/408,725 & 09/436,458

Prior application Information: Examiner *** Group/Art Unit: 2749

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

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Signature		Date	4/21/2000

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Applicant or Patentee: Ron Nevo et al. Attorney's Docket No.: 004198.P011X
Serial or Patent No.: Not yet assigned
Filed or Issued:
For: **MULTIPLE WIRELESS COMMUNICATION PROTOCOL METHODS AND APPARATUSES INCLUDING QUALITY OF SERVICE CONSIDERATIONS**

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
37 CFR 1.9 (f) and 1.27(c) - - SMALL BUSINESS CONCERN

I hereby declare that I am:

[ ] the owner of the small business concern identified below:
[XX] an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: Mobilian, Inc.
ADDRESS OF CONCERN: 7431 NW Evergreen Parkway, Suite 220
Hillsboro, Oregon 97124

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby certify that to the best of my knowledge and belief rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the **MULTIPLE WIRELESS COMMUNICATION PROTOCOL METHODS AND APPARATUSES INCLUDING QUALITY OF SERVICE CONSIDERATIONS**

by inventor(s) Ron Nevo and Xudong Zhao
described in

[XX] the specification being filed herewith
[ ] application serial no. _____, filed _____
[ ] patent no. _____, issued _____

and I have reviewed the document that evidences the conveyance of those rights. That document

[ ] is being filed herewith.
[ ] was recorded in the Patent and Trademark Office on _____, 19___ at reel ____ and frame _____.

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NAME:
ADDRESS:
[ ] Individual [ ] Small Business Concern [ ] Non-Profit Organization
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ADDRESS:
[ ] Individual [ ] Small Business Concern [ ] Non-Profit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Ron Nevo
TITLE OF PERSON OTHER THAN OWNER:
ADDRESS OF PERSON SIGNING: 7431 NW Evergreen Parkway, Suite 220, Hillsboro, Oregon 97124
SIGNATURE: _____ DATE: 4/21/2000

Our Ref.: 004198.P011x

APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

Multiple Wireless Communication Protocol Methods And Apparatuses *Including Quality Of Service Considerations*

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Date of Deposit April 21, 2000

Multiple Wireless Communication Protocol Methods and Apparatuses Including Quality of Service Considerations

Related Application

This application *is a continuation-in-part application of U.S. patent application number 09/439,946, filed on November 12, 2000, entitled Multiple Wireless Communication Protocol Methods and Apparatuses, which itself* is a continuation-in-part application of (a) U.S. patent application number 09/408,725, filed on September 29, 1999, entitled "A Wireless Apparatus Having Multiple Coordinated Transceivers For Multiple Wireless Communication Protocols", and (b) U.S. patent application number *09/436,458*, filed November 8, 1999, entitled "A Wireless Apparatus Having A Transceiver Equipped To Support Multiple Wireless Communication Protocols".

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of wireless communication. More specifically, the present invention relates to the problem of concurrent wireless communication with multiple communication partners of different wireless communication protocols.

2. Background Information

Advances in microprocessor and communication technology have led to the increase in popularity of wireless communication. Once confined to the privileged, wireless voice communication have become affordable and available to the masses.

Today, various efforts are under way to apply wireless communication to replace attachment cables used for attaching peripheral devices, such as printers, scanners and the like, as well as networking cables used for connecting clients, servers and the like. A leading candidate to accomplish the former is commonly known to those skilled in the art as the Bluetooth technology or Bluetooth protocol. *Examples of technology to accomplish the later include the different variants of the IEEE 802.11 Standard published by the Institute of Electrical and Electronic Engineers, 802.11 (Frequency Hoping, Direct Sequence), 802.11a, 802.1b, as well as Home RF, also known as Shared Wireless Access Protocol (SWAP) to those skilled in the art.*

A need has emerged in a number of applications that it is desirable for a device to be able to operate "concurrently" in multiple wireless protocols. One such applications is having a notebook computer being able to communicate with peripheral devices such as a phone, a printer, a scanner and the like, in accordance with the Bluetooth protocol; and with other computing devices, such as other peer computers or servers, communication devices, such as modems or adapters, and networking devices, such as gateways, routers, switches and the like, in accordance with one of the 802.11 protocols or Home RF.

However, the need cannot be met by simply providing the device with multiple transmitters, one for each protocol. The reason is because if multiple ones of these transmitters were to transmit at the same time. The transmitters are going to interfere with each other, resulting in corruption and/or loss of data, as well as degradation in performance.

As will be described in more detail below, the present invention substantially address this need in a very efficient and low cost manner. This and other advantages of the present invention will be readily apparent from the description to follow.

SUMMARY OF THE INVENTION

A multi-protocol wireless apparatus is provided with at least one wireless transceiver to transmit and receive signals in accordance with a first and a second protocol to and from first and second network devices of a first and a second wireless network communicatively coupled to the apparatus. The apparatus is further provided with at least one controller manager to operate the at least one wireless transceiver to perform the transmits and receives in accordance with the first and second protocols in a coordinated manner, taking into consideration quality of service criteria to be achieved for the respective protocols.

In one embodiment, the at least one controller manager is equipped with logic to determine message types of first messages to be transmitted to a selected one or selected ones of the first network devices in accordance with the first protocol, and to give priority to the first messages over second messages to be transmitted to a selected one or selected ones of the second network devices in accordance with the second protocol, if message types of the first messages are determined of a multi-media type.

In another embodiment, the at least one controller manager is equipped with logic to maintain a quality metric reflective of frequency of error for each voice stream, and to make its priority determination for messages competing to be transmitted to the first and second network devices in accordance with the first and second protocols in view of the quality metric maintained for each voice stream.

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BRIEF DESCRIPTION OF DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

Figure 1 illustrates an overview of the wireless device of the present invention, in accordance with one embodiment;

Figure 2 illustrates a period of operation of the wireless devices of **Fig. 1**, in accordance with one embodiment;

Figure 3 illustrates the wireless device of **Fig. 1** in further detail, in accordance with one implementation;

Figure 4 illustrates the operational states and flow of the state machine of **Fig. 3** in further detail, in accordance with one implementation;

Figure 5 illustrates the wireless device of **Fig. 1** in further detail, in accordance with another implementation;

Figure 6 illustrates the operational states and flow of the state machine of **Fig. 5** in further detail, in accordance with one implementation;

Figure 7 illustrates the wireless device of **Fig. 1** in further detail, in accordance with yet another implementation;

Figures 8a-8b illustrate a period of operation of the wireless devices of **Fig. 1**, in accordance with each of two alternate embodiments;

Figures 9a-9b illustrate the architecture and operational flow of the wireless device **100** of **Fig. 1** for practicing a selected one of the methods of operation of **Fig. 8a-8b**, in accordance with one embodiment;

Figure 10 illustrates a period of operation of the wireless devices of **Fig. 1**, in accordance with another embodiment;

Figures 11a-11b illustrate the architecture and operational flow of the wireless device **100** of **Fig. 1** for practicing the method of operation of **Fig. 11**, in accordance with one embodiment;

Figure 12 illustrates the concept of notch filtering,

Figure 13 illustrates an overview of the wireless device of the present invention, in accordance with another embodiment; *and*

Figure 14 *illustrates the essential operations of the operation flow of the controller managers in taking into consideration the quality of service criteria to be achieved for the respective protocols when controlling the transceivers to operate in a coordinated manner.*

Docket # 004198.P011x

DETAILED DESCRIPTION OF THE INVENTION

In the following description, various aspects of the present invention will be described. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some or all aspects of the present invention. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will also be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well known features are omitted or simplified in order not to obscure the present invention.

Parts of the description will be presented using software terminology commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. As well understood by those skilled in the art, these software quantities take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, and otherwise manipulated through mechanical and electrical components of a digital system; and the term digital system includes general purpose as well as special purpose processors, systems, and the like, that are standalone, adjunct or embedded.

Various operations will be described as multiple discrete steps performed in turn in a manner that is most helpful in understanding the present invention, however, the order of description should not be construed as to imply that these operations are necessarily order dependent, in particular, the order the steps are presented. Furthermore, the phrase "in one embodiment" will be used repeatedly, however the phrase does not necessarily refer to the same embodiment, although it may.

Referring now to **Figure 1**, wherein an overview of the present invention, in accordance with one embodiment, is shown. As illustrated, wireless device **100** is provided with wireless transceivers **102a** and **102b** to transmit and receive signals wirelessly in accordance with a first and a second wireless communication protocol, to enable device **100** to be communicatively coupled to devices **104a** and devices **104b** of wireless networks **108a** and **108b** respectively. Wireless device **100** further includes controller managers **106a** and **106b** to control the operation of wireless transceivers **102a** and **102b** respectively. As will be described in more detail below, controller managers **106a** and **106b** control transmits and receives by wireless transceivers **102a** and **102b**, in a coordinated manner, in accordance with the present invention, to allow wireless device **100** to operate with devices **104a** and devices **104b** of wireless network **108a** and **108b** in accordance with the respective wireless communication protocols at the same time.

In one embodiment, controller managers **106a** and **106b** control transmits and receives by wireless transceivers **102a** and **102b** (hereinafter, simply transceivers), in a coordinated manner. More specifically, in this embodiment, controller managers **106a** and **106b** control transceivers **102a** and **102b** to alternate between transmits by one of the two transceivers and receives by both of the two transceivers. **Figure 2** illustrates a period of operation in accordance with this embodiment. As shown, in time period T1, for duration t1, control manager **106a** controls transceiver **102a** to perform transmit of signals to devices **104a** of wireless network **108a** (hereinafter, simply network) in accordance with the first wireless communication protocol (hereinafter, simply protocol), while control manager **106b** controls transceiver **102b** to neither perform transmit nor receive of signals to and from devices **104b** of network **108b**. In time period T3, for duration t3, the reverse is performed. Control manager **106b** controls transceiver **102b** to perform transmit of

signals to devices **104b** of network **108b** in accordance with the second protocol, while control manager **106a** controls transceiver **102a** to neither perform transmit nor receive of signals to and from devices **104a** of network **108a**. In time periods T2 and T4, for duration t2 and t4 respectively, control managers **106a** and **106b** control both transceivers **102a** and **102b** to perform receive of signals from devices **104a** and **104b** of network **108a** and **108b** in accordance with the respective protocols respectively.

Since all wireless protocols operate on either a carrier sense or contention free protocol, devices **104a** are able to receive in time period T1, and transmit when there are packets to transmit, but otherwise receive, in time periods T2-T4. Likewise, devices **104b** are able to receive in time period T3, and transmit when there are packets to transmit, but otherwise receive, in time periods T1-T2 and T4.

Accordingly, wireless device **100** is able to operate with devices **104a** and **104b** of networks **108a** and **108b** in two wireless protocols at the same time.

Note that time periods T1-T4 may or may not be equal in duration. That is, numerically t1-t4 may or may not be equal. As will be described in more detail below, in different variants of this embodiment, duration t1-t4 of time periods T1-T4 are dynamically and adaptively set. In particular, in some variants, duration t1-t4 of time periods T1-T4 are adaptively set based at least in part of transmit and receive workloads of networks **108a** and **108b**.

Referring back to **Fig. 1**, except for the teachings of the present invention incorporated in wireless device **100** to effectuate the above described coordinated manner of operation of transceivers **102a** and **102b**, transceivers **102**a and **102b** as well as controller managers **106a** and **106b** are otherwise intended to represent a broad range of these elements known in the art. Accordingly, except for the teachings of the present invention, which will be further described below,

transceivers **102a** and **102b** and controller managers **106a** and **106b** will not be otherwise further described.

Wireless device **100** is intended to represent a wide range of devices that can benefit from having the ability to wirelessly operate with other wireless devices in two or more wireless communication protocols at the same time. Examples of device **100** include but not limited to computers of various form factors, such as desktop, notebook, palm size and so forth, controller devices (i.e. master devices) to manage and control the operation of networks **108a** and **108b**, and gateway devices to facilitate communication between devices **104a** and devices **104b**.

Likewise, devices **104a** and **104b** are intended to represent a broad range of devices that can benefit from being able to communicate wirelessly. Examples of devices **104a** include but not limited to phones, video cameras, speakers, modems, printers and scanners equipped to wireless communicate in accordance with the Bluetooth protocol. Examples of devices **104b** include clients and servers, as well as gateways, modems, hubs, routers, and switches equipped to wireless communicate in accordance with a selected variant of the IEEE 802.11 protocols or Home RF.

For ease of understanding, only two groups of devices **104a** and **104b**, communicating in accordance with the first and second wireless communication protocols are shown in **Fig. 1**. However, from the description to follow, it will be readily apparent to those skilled in the art, the present invention may be practiced with more than two transceivers (as long as the transceivers are likewise coordinated).

Referring now to **Figures 3** and **4**, wherein a block diagram and a state diagram illustrating wireless device **100** of **Fig. 1** in further detail, in accordance with

one embodiment, are shown. As illustrated, each controller manager **106a/106b** of wireless device **100** is endowed with a state machine **300a/300b** to complementarily assist the controller manager **106a/106b** to control its transceiver **102a/102b** in the above described coordinated manner. More specifically, each state machine **300a/300b**, in addition to idle state **410**, has four operating states **412-418** (TX, RX1, NOP, and RX2) to output a signal **304a/304b** denoting a selected one of a transmit (TX) operation, a receive (RX) operation and no-op (NOP) for its controller manager **106a/106b**.

Upon power-on or reset, each state machine **300a/300b** either transitions from idle state **410** to TX state **412** or NOP state **416**, depending on the state of configuration (config) signal **302a/302b**. One state machine, e.g. **300a**, is configured to transition from idle state **410** to TX state **412**, while the other state machine, e.g. **300b**, is configured to transition from idle state **410** to TX state **412**. Config signal **302a/302b** may be set e.g. via a jumper or other equivalent means, as well as through software.

While in TX state **412**, state machine **300a/300b** remains in the state for duration ts1, outputting signal **304a/304b** denoting TX operation for its controller manager **1026a/106b**. In one embodiment, where t1 and t3 may take on different values, one state machine, e.g. **300a**, is configured with ts1 set to t1, while the other state machine, e.g. **300b**, is configured with ts1 set to t3. Ts1 may be selectively set in any one of a number of techniques known in the art, e.g. through separate registers or multiplexing circuitry. Upon expiration of ts1, state machine **300a/300b** transitions from TX state **412** to RX1 state **414**.

While in RX1 state **414**, state machine **300a/300b** remains in the state for duration ts2, outputting signal **304a/304b** denoting RX operation for its controller manager **106a/106b**. In one embodiment, where t2 and t4 may take on different

values, one state machine, e.g. **300a**, is configured with ts2 set to t2, while the other state machine, e.g. **300b**, is configured with ts2 set to t4. Ts2 may likewise be selectively set in any one of a number of techniques known in the art. Upon expiration of ts2, state machine **300a/300b** transitions from RX1 state **414** to NOP state **416**.

While in NOP state **416**, state machine **300a/300b** remains in the state for duration ts3, outputting signal **304a/304b** denoting NOP for its controller manager **106a/106b**. In one embodiment, where t1 and t3 may take on different values, one state machine, e.g. **300a**, is configured with ts3 set to t3, while the other state machine, e.g. **300b**, is configured with ts3 set to t1. Ts3 may likewise be selectively set in any one of a number of techniques known in the art. Upon expiration of ts3, state machine **300a/300b** transitions from NOP state **416** to RX2 state **418**.

While in RX2 state **418**, state machine **300a/300b** remains in the state for duration ts4, outputting signal **304a/304b** denoting RX operation for its controller manager **106a/106b**. In one embodiment, where t2 and t4 may take on different values, one state machine, e.g. **300a**, is configured with ts4 set to t4, while the other state machine, e.g. **300b**, is configured with ts4 set to t2. Ts4 may likewise be selectively set in any one of a number of techniques known in the art. Upon expiration of ts4, state machine **300a/300b** transitions from RX2 state **418** to TX state **412**.

From TX state **412**, state machine **300a/300b** continues operation as described earlier.

Referring now to **Figures 5** and **6**, wherein a block diagram and a state diagram illustrating wireless device **100** of **Fig. 1** in further detail, in accordance with another embodiment, are shown. As illustrated, for this embodiment, instead of

having each controller manager **106a/106b** of wireless device **100** be endowed with a state machine to complementarily assist the controller manager **106a/106b** to control its transceiver **102a/102b** in the above described coordinated manner, wireless device **100** is endowed with a single state machine **500** to assist both controller managers **106a** and **106b**. Similarly, state machine **500**, in addition to idle state **610**, has four operating states **612-618** (S1 – S4) to output a pair of signals **504a-504b** denoting a selected combination of operations, TX with NOP, both RX, and NOP with TX for controller managers **106a** and **106b**.

Upon power-on or reset, state machine **500** transitions from idle state **610** to S1 state **612**. While in S1 state **612**, state machine **500** remains in the state for duration ts1, outputting signal **504a-504b** denoting TX and NOP for controller managers **106a** and **106b**. Ts1 is set to t1. Upon expiration of ts1, state machine **500** transitions from S1 state **612** to S2 state **614**. While in S2 state **614**, state machine **500** remains in the state for duration ts2, outputting signal **504a-504b** denoting RX for both controller managers **106a** and **106b**. Ts2 is set to t2. Upon expiration of ts2, state machine **500** transitions from S2 state **614** to S3 state **616**.

While in S3 state **616**, state machine **500** remains in the state for duration ts3, outputting signal **504a-504b** denoting NOP and TX for controller managers **106a** and **106b**. Ts3 is set to t3. Upon expiration of ts3, state machine **500** transitions from S3 state **616** to S4 state **618**. While in S4 state **618**, state machine **500** remains in the state for duration ts4, outputting signal **504a-504b** denoting RX for both controller managers **106a** and **106b**. Ts4 is set to t4. Upon expiration of ts4, state machine **500** transitions from S4 state **618** to S1 state **612**.

From S1 state **612**, state machine **500** continues operation as described earlier.

Referring now to **Figure 7**, wherein a block diagram illustrating wireless device **100** of **Fig. 1** in further detail, in accordance with yet another embodiment, is shown. As illustrated, for this embodiment, in addition to having wireless device **100** be endowed with a single state machine **700** to assist both controller managers **106a** and **106b** as described earlier (with signals **708a-708a** denoting TX-NOP, RX-RX or NOP-TX), wireless device **100** is further endowed with register **702**, time sharing manager **704**, and workload monitor **706** operatively coupled to each other and state machine **700** as shown. Register **702** stores t1-t4 for state machine **700**. Time sharing manager **704** dynamically adjusts t1-t4 to enable state machine **700** be able to adaptively assist controller managers **106a** and **106b** in controlling transceivers **102a** and **102b**. For the illustrated embodiment, time sharing manager **704** dynamically adjusts t1-t4 based at least in part on transmit and receive workloads of networks **108a** and **108b**. Transmit and receive workloads are monitored by workload monitor **706** and provided to time sharing manager **704**.

Register **702** may be constituted with any storage circuitry known in the art. Time sharing manager **704** and workload monitor **706** may be implemented with any combinatorial logic or in software.

Referring now to **Figures 8a-8b**, wherein a period of operation for the wireless devices of **Fig. 1** in accordance with each of two alternate embodiments are shown. In each of these two alternate embodiments, first protocol of wireless devices **104a** of network **108a** is assumed to be a frequency hopping protocol as shown, i.e. wireless devices **104a** hop from frequency to frequency in accordance with a pseudo random pattern to transmit signals. For ease of understanding, second protocol of wireless devices **104b** of network **108b** is assumed to be a constant frequency protocol (although in alternate embodiments, it may also be a

frequency hopping protocol). In any event, to illustrate the present invention, at least one of the frequencies of the first protocol is the same frequency of the second protocol. Thus, if some of devices **104a** and **104b** are located sufficiently close to each other, and when one of devices **104a** selects the same frequency for transmission, interference (or collision) between these devices will occur, resulting in one or more transmission failures. For the illustrated example, frequency interference (or collision) is shown to occur at the 7^{th} and 14^{th} hop (f_7 and f_{14}). That is, in accordance with the pseudo random pattern, in each of these two hops, devices **104a** transmit in the same frequency employed by devices **104b**. An example of a frequency hopping protocol is the Bluetooth protocol, and an example of a protocol having an interfering frequency with Bluetooth is the 802.11 protocol. [Note that the example interference at the 7^{th} and 14^{th} hop is not intended to suggest that the interference occurs at every 7^{th} hop. The interference pattern is dictated by the intersection of the pseudo random pattern followed by the frequency hopping devices **104a** and the frequency employed by devices **104b**.]

To further improve the operating efficiencies of both network, instead of just letting the interfering devices **104a** and **104b** resolve each of the frequency interference, after it occurred, through conventional collision detection, back off and retry approaches, wireless device **100** coordinates the operation of devices **104a** and **104b** to proactively reduce actual occurrence of interference. More specifically, for the illustrated embodiments, either devices **104a** or devices **104b** are selected to be the "dominant" devices. The non-selected devices are considered to be the dominated devices. The dominated devices are notified, from time to time, to suspend operation to pro-actively avoid interference with the dominant devices, allowing the dominant devices to continue to operate without interference. As result, the time consuming collision detection, back off and retries are substantially

reduced, and experience has shown that the overall operating efficiencies of both networks improve, the dominated network as well as the dominant network.

Fig. 8a illustrates a period of operation when devices **104a**, the frequency hopping devices, are selected to be the dominant devices, while **Fig. 8b** illustrates a period of operation when devices **104b** are selected to be the dominant devices. That is, under **Fig. 8a**, devices **104b**, upon informed, will temporarily suspend operation to proactively avoid interference, whereas under **Fig. 8b**, devices **104a**, upon informed, will temporarily suspend operation to proactively avoid interference.

Under either one of these embodiments, wireless device **100** basically operates as earlier described. Except wireless device **100** assumes the additional responsibilities of determining the pseudo random frequency hopping pattern of devices **104a** (in one embodiment, including the interfering frequency), selecting either devices **104a** or **104b** to be the dominated devices, predicting the occurrence of interference, and preemptively notifying the dominated devices to suspend operation to avoid interference (in one embodiment, conditionally suspending operation).

Referring now to **Figs. 9a-9b**, wherein the architecture and operational flow of wireless device **100** having these added responsibilities are shown. As illustrated in **Fig. 9a**, wireless device **100** is basically the embodiment earlier described referencing **Fig. 7**, except wireless device **100** is further provided with network management application (or network manager) **904** to proactively managing network devices **104a** and **104b** to reduce actual occurrence of interference. Network manager **904** also subsumes the earlier described responsibilities of time sharing manager **704**, i.e. monitoring the workloads of the two protocols, and adaptively setting the values of t1-t4 for time period T1-T4.

Operationally, as illustrated in **Fig. 9b**, upon initialization, network manager **904** monitors the operation of devices **104a** and **104b** for an observation period, and determines the pseudo random frequency hopping pattern followed by devices **104a** (and in one embodiment, the interfering frequency with devices **104b**), **912**. This may be accomplished using any one of a number of techniques known in the art. Next, network manager **904** selects either devices **104a** or devices **104b** to be the dominant devices, **914**. In one embodiment, network manager **904** makes the selection in accordance with configuration information programmed in configuration register **902**. In alternate embodiments, other configuration registers, or other techniques known in the art, such as jumpers, may also be employed to assist network manager **904** in making the selection.

Then, on an on going basis, network manager **904**, predicts when interference will occur, using the determined pseudo random pattern and interference frequency, **916**. Whenever, an interference is to occur, network manager **904** preemptively notifies the dominated devices to suspend operation accordingly, thereby allowing the dominant devices to operate without interference, **918**. [In one embodiment, if the dominated devices are devices **104a**, the notification includes the interfering frequency, and the suspension is conditional, only if the predicted frequency is indeed the interfering frequency.] The process continues, as long as there are wireless devices of both types **104a** and **104b** operating.

In one embodiment, network manager **904** repeats the calibration periodically. In yet another embodiment, network manager **904** monitors actual interference between devices **104a** and **104b**, and tracks the mean time between interference. Network manager **904** repeats the calibration, whenever the tracked mean time between interference drops below certain given performance level.

Note that in embodiments where the number of devices **104a** and **104b** present in networks **108a** and **108b** are relatively small, including in particular, the simplest case where there is only one device **104a** and one device **104b** in networks **108a** and **108** respectively, network manager **904** may make the selection of the dominated devices in a dynamic and individualized manner, when an interference is predicted to occur. That is, different device or devices **104a** and **104b** are dynamically and individually selected for different predictions of interference. Such dynamic, individualized manner of selection may also be made in view of the workloads of the two protocols.

As those skilled in the art would appreciate, the above described improved manner of operation (including the embodiment, where suspension is to be conditionally made by devices **104a**) may be practiced with minimal or no change to devices **104,a** and **104a**, as virtually all network devices are capable of temporarily suspending operation responsive to a request. As to the embodiment where suspension is to be conditionally made by devices **104a**, the conditional performance may be effectuated through addition of simple frequency testing combinatorial logic.

*Additionally, in yet other embodiments, upon selecting the dominated devices at **914**, wireless device **100** notifies devices **104a** and **104b** of their respective roles, i.e. whether they are the dominating devices or dominated devices. Further, at least the dominated devices are also provided with a collision map, for the dominated devices to self determine whether interference is to occur. In other words, operation **916** is distributed to the dominated devices, and operation **918** is eliminated.*

Referring now to **Figure 10**, wherein a period of operation for the wireless devices of **Fig. 1** in accordance with another embodiment is shown. Again, first

protocol of wireless devices **104a** of network **108a** is assumed to be a frequency hopping protocol, and second protocol of wireless devices **104b** of network **108b** is assumed to be a constant frequency protocol (although it may also be a frequency hopping protocol). Nevertheless, for illustrative purpose, it is suffice that at least one of the frequencies of the first protocol of wireless devices **104a** conflicts with the frequency of the second protocol of wireless devices **104b** as shown, and earlier described. Thus, in like manner, if some of devices **104a** and **104b** are located sufficiently close to each other, and devices **104a** select to transmit in the same frequency, interference (or collision) will occur, resulting in one or more transmission failures. To further improve the operating efficiencies of both network, instead of just letting the interfering devices **104a** and **104b** resolve each of the frequency interference, after it occurred, through conventional collision detection, back off and retry approaches, wireless device **100** coordinates the operation of devices **104a** and **104b** to proactively reduce actual occurrence of interference. More specifically, under this embodiment, devices **104a** and **104b** are correspondingly notified of the filtering to be employed to correspondingly cancel the respective interfering signals, and when to apply the filtering. As will be described in more detail below, in one embodiment, the filtering to be employed is a notch filter inversely formed in accordance with the other devices' signal. As a result, the time consuming collision detection, back off and retries are also substantially reduced, and experience has shown that the overall operating efficiencies of both networks also improve.

As illustrated in **Fig. 10**, at each predicted occurrence of interference, both devices **104a** and **104b** apply the corresponding required filtering to correspondingly cancel the respective interfering signals. As before, the basic operations of wireless device **100** remain substantially unchanged, except, wireless device **100** assumes the additional responsibilities of determining the pseudo random frequency hopping

pattern of devices **104a**, the interfering frequency, the corresponding filtering to be employed to cancel the respective interfering signals, and preemptively notifying devices **104a** and **104b** of the determined filtering as well as when to apply them.

Referring now to **Figs. 11a-11b**, wherein the architecture and operational flow of wireless device **100** having these added responsibilities are shown. As illustrated in **Fig. 11a**, wireless device **100** is basically the embodiment earlier described referencing **Fig. 9a**. That is, wireless device **100** is also additionally provided with network manager **1104**, except the additional responsibilities assumed by network manager **1104** to proactively reduce interference are slightly different.

As illustrated in **Fig. 11b**, upon initialization, network manager **1104** monitors the operation of devices **104a** and **104b** for an observation period, and determines the pseudo random frequency hopping pattern followed by devices **104a**, and the interfering frequency with devices **104b**, **1112**. This again may be accomplished using any one of a number of techniques known in the art. Next, network manager **1104** determines the corresponding filtering to be employed by devices **104a** and **104b** to correspondingly cancel their respective interfering signals of "the other devices", and provides the determined information to devices **104a** and **104b**, **1114**. In one embodiment, as alluded to earlier, the corresponding filtering to be employed are notched filters inversely constructed in accordance with the other devices' signals (see **Fig. 12**). That is, devices **104a** are to apply a notch filter, inversely formed in accordance with transmit signals of devices **104b**, whereas, devices **104b** are to apply a notch filter, inversely formed in accordance with transmit signals of devices **104a**. [Notch filters in general are known in the art, and will not be further described.]

Then, on an on going basis, network manager **1104**, predicts when interference will occur, using the determined pseudo random pattern and

interference frequency, **1116**. Whenever, an interference is to occur, network manager **1104** preemptively notifies devices **104a** and **104b** to correspondingly apply their corresponding filtering, thereby allowing both devices **104a** and **104b** to operate without interference, **1118**. The process continues, as long as there are wireless devices of both types **104a** and **104b** operating. [Likewise, the application of filtering by devices **104a** may also be conditionally performed, only if the frequency is indeed the same as the interfering frequency.]

As before, in one embodiment, network manager **1104** repeats the calibration periodically. In yet another embodiment, network manager **1104** monitors actual interference between devices **104a** and **104b**, and tracks the mean time between interference. Network manager **1104** repeats the calibration, whenever the tracked mean time between interference drops below certain given performance level.

As those skill in the art will appreciate, the immediately described improved manner of operation may also be practiced with minimal change to devices **104a** and **104a**, by equipping both types of network devices with the ability to responsively apply notch filtering. [Likewise, devices **104a** may be additionally provided with simple combinatorial logic to effectuate the conditional application of notch filtering.]

*Similar to the embodiments described with references to **Figs. 8a-8b** and **9a-9b**, in yet other embodiments, in addition to notifying the devices of the required filtering at **1114**, wireless device **100** provides the devices with a collision map, such that the devices can self determine whether interference is to occur, and the appropriate filtering to be applied. In other words, operation **1116** is distributed to the devices, and operation **1118** is eliminated.*

*Referring now to back to **Figure 1**, where the overview of wireless device **100** of the present invention is illustrated. In this embodiment, controller managers **106** in operating wireless device **100** additionally take into consideration quality of service criteria to be achieved for the respective protocol.*

In one embodiment, the at least one controller manager is equipped with logic to determine message types of first messages to be transmitted to a selected one or selected ones of the first network devices in accordance with the first protocol, and to give priority to the first messages over second messages to be transmitted to a selected one or selected ones of the second network devices in accordance with the second protocol, if message types of the first messages are determined of a multi-media type.

*In another embodiment, the at least one controller manager is equipped with logic to maintain a quality metric reflective of frequency of error for each voice stream, and to make its priority determination for messages competing to be transmitted to the first and second network devices in accordance with the first and second protocols in view of the quality metric maintained for each voice stream. **Fig. 14** illustrates the essential operations of the operation flow of controller managers **106** for such embodiment, for taking into consideration quality of service criteria through quality metrics reflective of the frequency of error for each voice stream.*

*As illustrated, at instantiation of each voice stream (or other data streams having like kind of "not to exceed" error rate threshold requirements), **1402**, the controller managers establish and initialize a message transmitted counter for the voice stream being instantiated. Thereafter, for each message to be transmitted, the controller managers determine if the message is for a voice stream, **1404**. If not, the message is handled in any one of a number of application dependent manner*

*1405. The exact manner is not relevant to the practice of the present invention. If it is message for a voice stream, the controller managers further determines if the message is in competition for priority with another message to be transmitted in accordance with the other protocol, **1406**. If not, the message is transmitted, **1408**. If the message is in competition for priority with another message to be transmitted in accordance with the other protocol, the controller managers further determine if at least m messages have been successfully transmitted consecutively for the voice stream, **1410**. M is greater than 1/e, where e is an error percentage rate not to be exceeded. If not more than m messages have been successfully transmitted consecutively for the voice stream, priority is given to the message for the voice stream, and the message is transmitted, **1408**. Upon transmission of a message for a voice stream, the controller managers increment the message transmitted counter corresponding to the voice stream, **1412**. On the other hand, if at least m messages have been successfully transmitted consecutively for the voice stream, priority is given to the other message, allowing the message for the voice stream to be dropped, **1414**. Upon dropping a message for a voice stream, the controller managers reset the message transmitted counter for the voice stream, **1416**.*

*In an alternate embodiment, operation **1410** is not merely performed with respect to a single successful consecutive transmission threshold. Instead, a more sophisticated approach involving the message type of the priority competing message and multiple successful consecutive transmission thresholds is employed. More specifically, the controller managers would determine if the priority competing message is of a first message type or a second message type. If it is of the first message type, than priority is given to the message of the voice stream unless at least m1 messages for the voice stream have been successfully transmitted consecutively for the voice stream. If at least m1 messages for the voice stream*

have been successfully transmitted consecutively for the voice stream, priority is given for the other message of the first message type. M1 is a first multiplier of 1/e1, where e1 is as earlier defined. However, if it is of the second message type, than priority is given to the message of the voice stream unless at least m2 messages for the voice stream have been successfully transmitted consecutively for the voice stream. If at least m2 messages for the voice stream have been successfully transmitted consecutively for the voice stream, priority is given for the other message of the second message type. M2 is a second multiplier of 1/e2, and greater than m1. In one embodiment, the first message type is "acknowledgement" message type, and the second message type is a data message type.

In alternate embodiment, the present invention may also be practiced with more than two message categorizations and corresponding quality thresholds.

Thus, it can be seen by employing increasing number of message categorizations and corresponding quality thresholds, transmits and receives of the respective protocols can be controlled with increased granularity.

Referring now to **Figure 13**, wherein an overview of the present invention, in accordance with another embodiment, is shown. Similar to the embodiment of **Fig. 1**, wireless device **100** is communicatively coupled to devices **104a** and devices **104b** of wireless networks **108a** and **108b** respectively. Wireless device **100** performs transmits and receives of the two protocols, in a coordinated manner, to allow wireless device **100** to operate with devices **104a** and devices **104b** of wireless network **108a** and **108b** in accordance with the respective protocols at the same time. However, unlike *all the earlier described embodiments*, wireless device **100** is provided with a single wireless transceiver **1302**, which includes joint signal transmit/receive section **1303**, and a number of transmit and receive signals

up/down conversion sections **1205** sharing joint signal transmit/receive section **1303**. Wireless device **100** further includes controller/signal processing (C/SP) section **1306** to process data for transmission by wireless transceiver **1302**, to process signals received by wireless transceiver **1302**, and to control the data/signal processing operations as well as the operation of wireless transceiver **1302**. The constitution and operations of wireless device **100** is the subject of the second parent application, number *09/436,458*, which is hereby fully incorporated by reference. Additionally, in some embodiments, wireless device **100** is endowed with a network manager equipped with the capabilities earlier described referencing **Figs. 8a-8b** and **9a-9b**. In other embodiments, wireless device **100** is endowed with a network manager equipped with the capabilities earlier described referencing **Figs. 10** and **11a-11b**. *In yet other embodiments, wireless device **100** is endowed with the capabilities earlier described referencing **Figs. 15**.* In one words, the capabilities and methods of operations described referencing **Figs 8a-8b** and **9a-9b**, **Figs. 10** and **11a-11b**, *and **Fig. 15**,* may be practiced with the multiple protocol wireless apparatus of the first parent application, number 09/408,725, or the multiple protocol wireless apparatus of the second parent application.

Thus, a wireless device equipped to substantially operate currently with multiple wireless communication protocols, and various associated methods of operations, *including taking into consideration quality of service,* have been described. While the present invention has been described in terms of the above illustrated embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described. The present invention can be practiced with modification and alteration within the spirit and scope of the appended claims. The

description is thus to be regarded as illustrative instead of restrictive on the present invention.

CLAIMS

What is claimed is:

1. An apparatus comprising:

at least one wireless transceiver to transmit and receive signals in accordance with a first and a second protocol to and from first and second network devices of a first and a second wireless network communicatively coupled to the apparatus; and

at least one controller manager coupled to said at least one wireless transceiver to operate said at least one wireless transceiver to perform said transmits and receives in accordance with said first and second protocols in a coordinated manner, taking into consideration quality of service criteria to be achieved for the respective protocols.

2. The apparatus of claim 1, wherein said at least one controller manager is equipped with logic to determine message types of first messages to be transmitted to a selected one or selected ones of said first network devices in accordance with said first protocol, and to give priority to said first messages over second messages to be transmitted to a selected one or selected ones of said second network devices in accordance with said second protocol, if message types of said first messages are determined of a multi-media type.

3. The apparatus of claim 1, wherein said at least one controller manager is equipped with logic to maintain a quality metric reflective of frequency of error for each voice stream, and to make its priority determination for messages competing to

be transmitted to said first and second network devices in accordance with said first and second protocols in view of said quality metric maintained for each voice stream.

4. The apparatus of claim 3, wherein said at least one controller manager is equipped with logic to increment a message transmitted counter corresponding to a voice stream whenever a message is transmitted for the voice stream, and not dropping a message of the voice stream until at least m messages have been successfully transmitted consecutively for the voice stream, where m is greater than 1/e, and e is an error percentage rate not to be exceeded.

5. The apparatus of claim 4, wherein said at least one controller manager is further equipped with logic to reset a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m messages have been successfully transmitted consecutively for the voice stream.

6. The apparatus of claim 3, wherein said at least one controller manager is equipped with logic to increment a message transmitted counter corresponding to a voice stream whenever a message is transmitted for the voice stream in accordance with said first protocol, and not dropping a message of the voice stream in favor of a message of a first message type to be transmitted in accordance with said second protocol until at least m1 messages have been successfully transmitted consecutively for the voice stream, where m1 is greater than a first multiple of 1/e, and e is an error percentage rate not to be exceeded.

7. The apparatus of claim 6, wherein said message of the first message type to be transmitted in accordance with said second protocol is an acknowledgement message.

8. The apparatus of claim 6, wherein said logic further not dropping a message of the voice stream in favor of a message of a second message type to be transmitted in accordance with said second protocol until at least m2 messages have been successfully transmitted consecutively for the voice stream, where m2 is greater than a second multiple of 1/e, which is greater than m1.

9. The apparatus of claim 8, wherein said message of the second message type to be transmitted in accordance with said second protocol is a data message.

10. The apparatus of claim 8, wherein said at least one controller manager is further equipped with logic to reset a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m1/m2 messages have been successfully transmitted consecutively for the voice stream.

11. The apparatus of claim 1, wherein the first and the second protocol are two protocols selected from a group consisting of Bluetooth, 802.11 frequency hopping, 802.11 direct sequence, 802.11a, 802.11b, and Home RF.

12. The apparatus of claim 1, wherein the apparatus is a computer having a form factor selected from a group consisting of a desktop type, a notebook type and a palm sized type.

13. In an apparatus having at least one wireless transceiver and at least one controller manager; a method of operation comprising:

controlling said at least one wireless transceiver to transmit and receive signals in accordance with a first protocol to and from first network devices of a first wireless network; and

controlling said at least one wireless transceiver to transmit and receive signals in accordance with a second protocol to and from second network devices of a second wireless network;

wherein both of said controlling are performed in a coordinated manner, including taking into consideration quality of service criteria to be achieved for the respective protocols.

14. The method of claim 13, said taking into consideration quality of service criteria to be achieved for the respective protocols comprises determining message types of first messages to be transmitted to a selected one or selected ones of said first network devices in accordance with said first protocol, and giving priority to said first messages over second messages to be transmitted to a selected one or selected ones of said second network devices in accordance with said second protocol, if message types of said first messages are determined of a multi-media type.

15. The method of claim 13, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols comprises maintaining a quality metric reflective of frequency of error for each voice stream, and making priority determination for messages competing to be transmitted to said first and

second network devices in accordance with said first and second protocols in view of said quality metric maintained for each voice stream.

16. The method of claim 15, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols comprises incrementing a message transmitted counter corresponding to a voice stream whenever a message is transmitted for the voice stream, and not dropping a message of the voice stream until at least m messages have been successfully transmitted consecutively for the voice stream, where m is greater than 1/e, and e is an error percentage rate not to be exceeded.

17. The method of claim 16, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols comprises resetting a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m messages have been successfully transmitted consecutively for the voice stream.

18. The method of claim 15, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols comprises incrementing a message transmitted counter corresponding to a voice stream whenever a message is transmitted for the voice stream in accordance with said first protocol, and not dropping a message of the voice stream in favor of a message of a first message type to be transmitted in accordance with said second protocol until at least m1 messages have been successfully transmitted consecutively for the voice stream, where m1 is greater than a first multiple of 1/e, and e is an error percentage rate not to be exceeded.

19. The method of claim 18, wherein said message of the first message type to be transmitted in accordance with said second protocol is an acknowledgement message.

20. The method of claim 18, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols further comprises not dropping a message of the voice stream in favor of a message of a second message type to be transmitted in accordance with said second protocol until at least m2 messages have been successfully transmitted consecutively for the voice stream, where m2 is greater than a second multiple of 1/e, which is greater than m1.

21. The method of claim 20, wherein said message of the second message type to be transmitted in accordance with said second protocol is a data message.

22. The method of claim 20, wherein said taking into consideration quality of service criteria to be achieved for the respective protocols further comprises resetting a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m1/m2 messages have been successfully transmitted consecutively for the voice stream.

23. A collection of networked apparatuses comprising:

a first plurality of apparatuses wirelessly networked together, with each apparatus being equipped to communicate wirelessly in accordance with a first protocol;

a second plurality of apparatuses wirelessly networked together, with each apparatus being equipped to communicate wirelessly in accordance with a second protocol; and

a multi-protocol apparatus equipped to communicate wirelessly with said first and second plurality of apparatuses in accordance with said first and second protocols respectively, in a coordinated manner, including having been equipped to take into consideration quality of service criteria to be achieved for the respective protocols..

24. The apparatuses of claim 23, wherein said multi-protocol apparatus is equipped with logic to determine message types of first messages to be transmitted to a selected one or selected ones of said first network devices in accordance with said first protocol, and to give priority to said first messages over second messages to be transmitted to a selected one or selected ones of said second network devices in accordance with said second protocol, if message types of said first messages are determined of a multi-media type.

25. The apparatuses of claim 23, wherein said multi-protocol apparatus is equipped with logic to maintain a quality metric reflective of frequency of error for each voice stream, and to make its priority determination for messages competing to be transmitted to said first and second network devices in accordance with said first and second protocols in view of said quality metric maintained for each voice stream.

26. The apparatuses of claim 25, wherein said multi-protocol apparatus is equipped with logic to increment a message transmitted counter corresponding to a

voice stream whenever a message is transmitted for the voice stream, and not dropping a message of the voice stream until at least m messages have been successfully transmitted consecutively for the voice stream, where m is greater than 1/e, and e is an error percentage rate not to be exceeded.

27. The apparatuses of claim 26, wherein said multi-protocol apparatus is further equipped with logic to reset a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m messages have been successfully transmitted consecutively for the voice stream.

28. The apparatuses of claim 25, wherein said multi-protocol apparatus is equipped with logic to increment a message transmitted counter corresponding to a voice stream whenever a message is transmitted for the voice stream in accordance with said first protocol, and not dropping a message of the voice stream in favor of a message of a first message type to be transmitted in accordance with said second protocol until at least m1 messages have been successfully transmitted consecutively for the voice stream, where m1 is greater than a first multiple of 1/e, and e is an error percentage rate not to be exceeded.

29. The apparatuses of claim 28, wherein said message of the first message type to be transmitted in accordance with said second protocol is an acknowledgement message.

30. The apparatuses of claim 28, wherein said logic further not dropping a message of the voice stream in favor of a message of a second message type to be transmitted in accordance with said second protocol until at least m2 messages

have been successfully transmitted consecutively for the voice stream, where m2 is greater than a second multiple of 1/e, which is greater than m1.

31. The apparatuses of claim 30, wherein said message of the second message type to be transmitted in accordance with said second protocol is a data message.

32. The apparatuses of claim 30, wherein said multi-protocol apparatus is further equipped with logic to reset a message transmitted counter corresponding to a voice stream when a message of the voice stream is dropped after at least m1/m2 messages have been successfully transmitted consecutively for the voice stream.

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ABSTRACT OF THE DISCLOSURE

A multi-protocol wireless apparatus is provided with at least one wireless transceiver to transmit and receive signals in accordance with a first and a second protocol to and from first and second network devices of a first and a second wireless network communicatively coupled to the apparatus. The apparatus is further provided with at least one controller manager to operate the at least one wireless transceiver to perform the transmits and receives in accordance with the first and second protocols in a coordinated manner, taking into consideration quality of service criteria to be achieved for the respective protocols.

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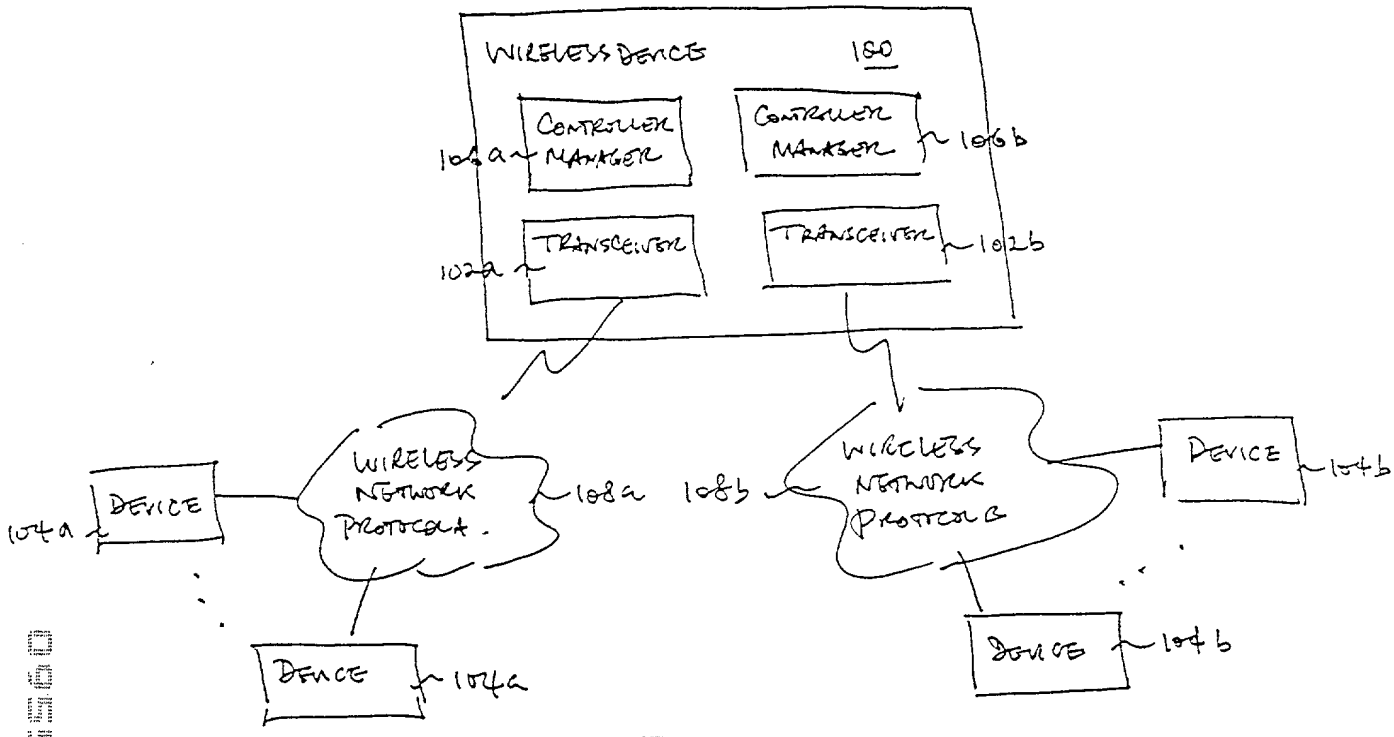
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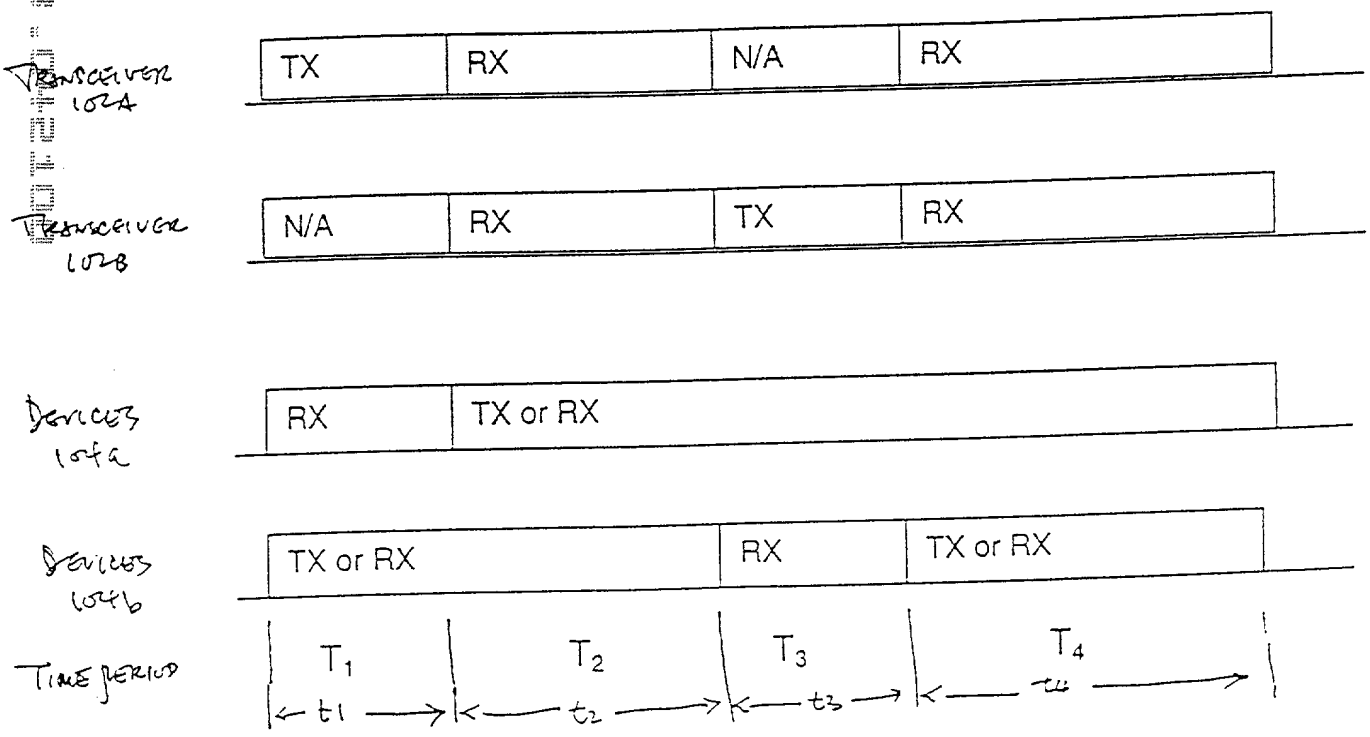
DEVICE
DEVICE

FIG. 1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t4

FIG. 2

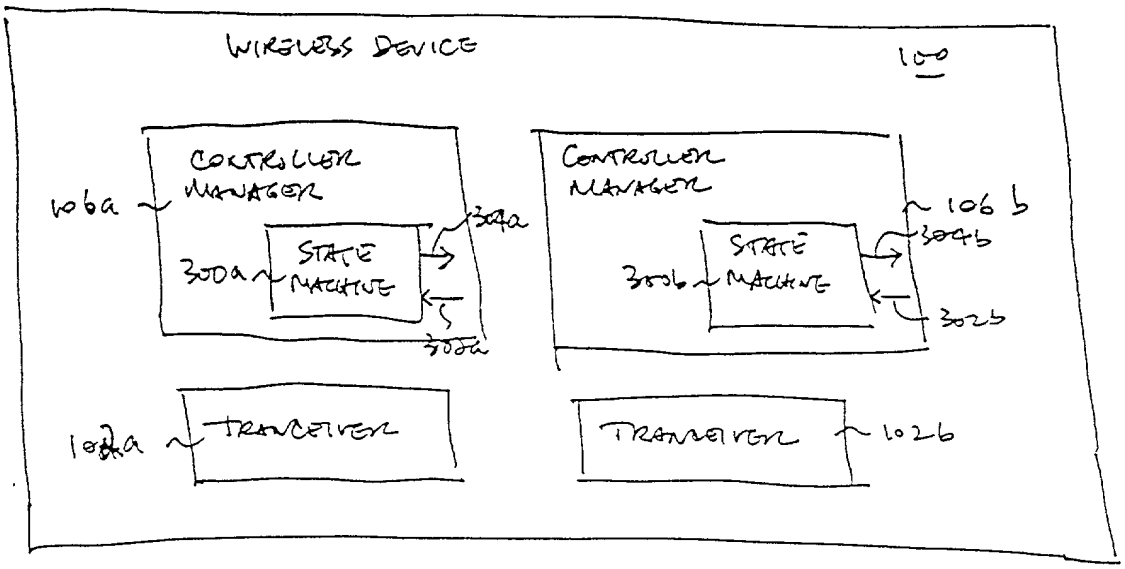
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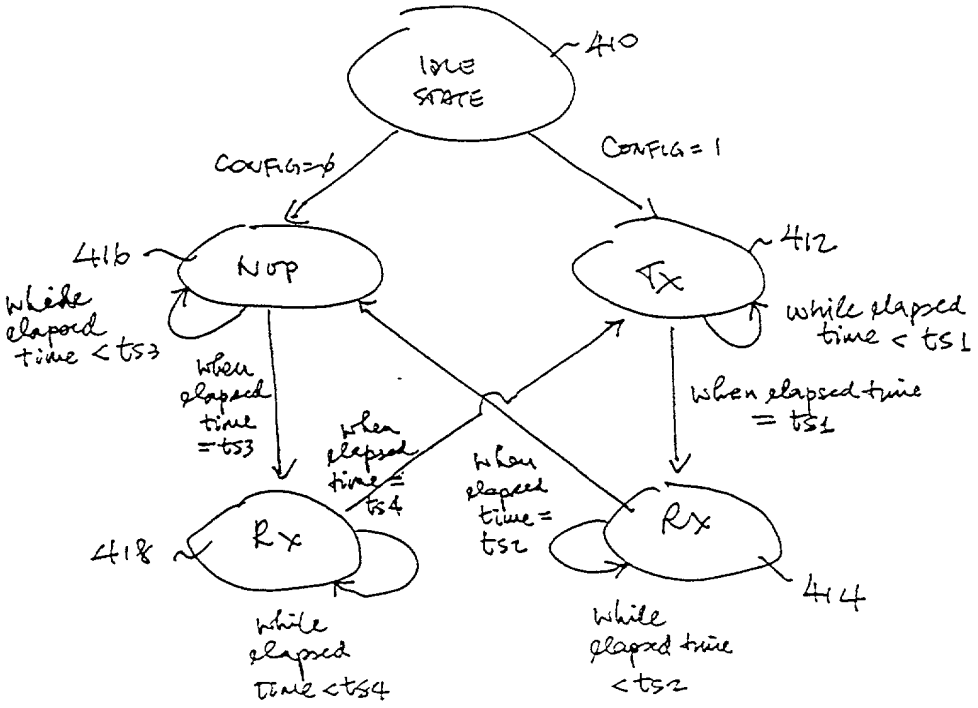
FIG. 3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when elapsed time = ts4
while elapsed time < ts4
RX
414
when elapsed time = ts2
while elapsed time < ts2

FIG. 4

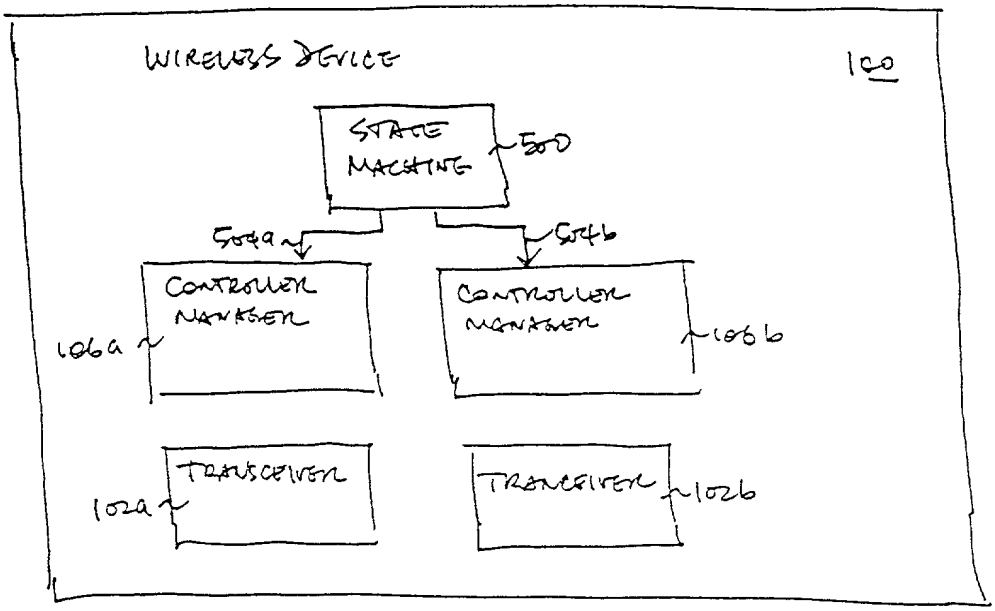
WIRELESS DEVICE
100
STATE MACHINE
500
504a
504b
CONTROLLER MANAGER
106a
CONTROLLER MANAGER
106b
TRANSCEIVER
102a
TRANSCEIVER
102b

FIG. 5

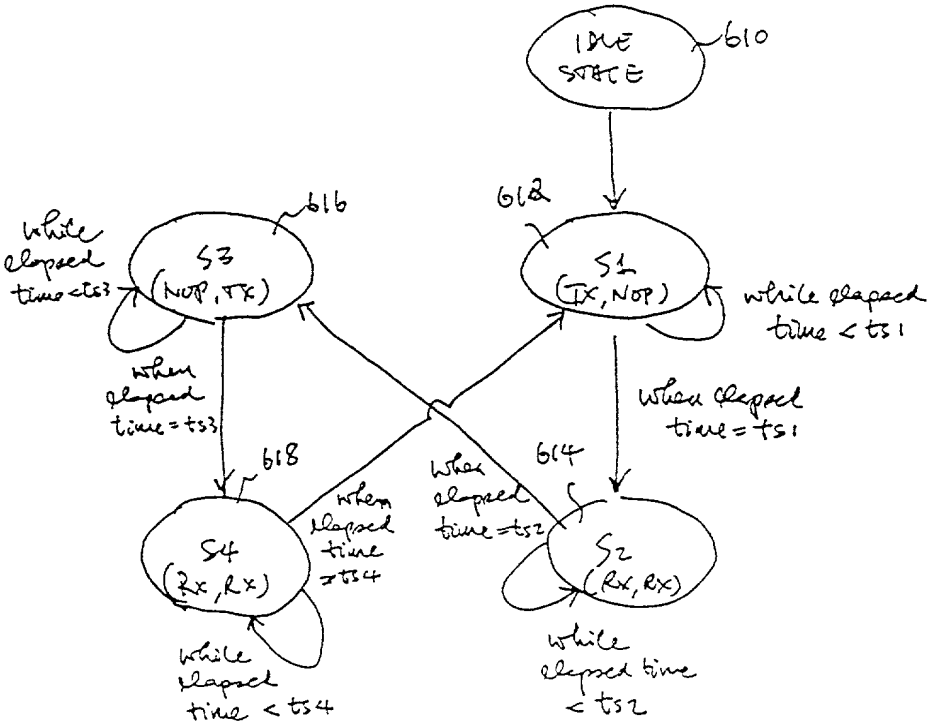
IDLE STATE
610
612
S1 (TX, NOP)
while elapsed time < ts1
when elapsed time = ts1
614
S2 (Rx, Rx)
while elapsed time < ts2
when elapsed time = ts2
616
S3 (NOP, TX)
while elapsed time < ts3
when elapsed time = ts3
618
S4 (Rx, Rx)
while elapsed time < ts4
when elapsed time = ts4

FIG. 6

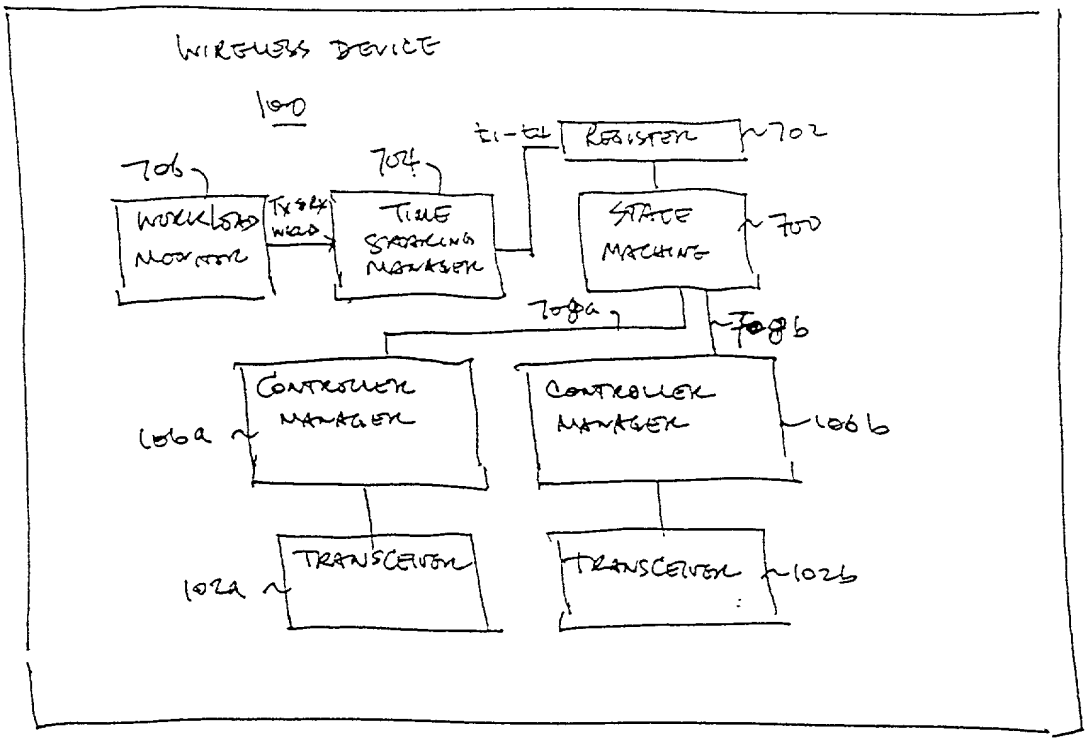
WIRELESS DEVICE
100
t1-t2
REGISTER
702
706
704
WORKLOAD MONITOR
TX & RX WLD
TIME STARTING MANAGER
STATE MACHINE
700
708a
708b
CONTROLLER MANAGER
106a
CONTROLLER MANAGER
106b
TRANSCEIVER
102a
TRANSCEIVER
102b

FIG. 7

0076WO 3102560

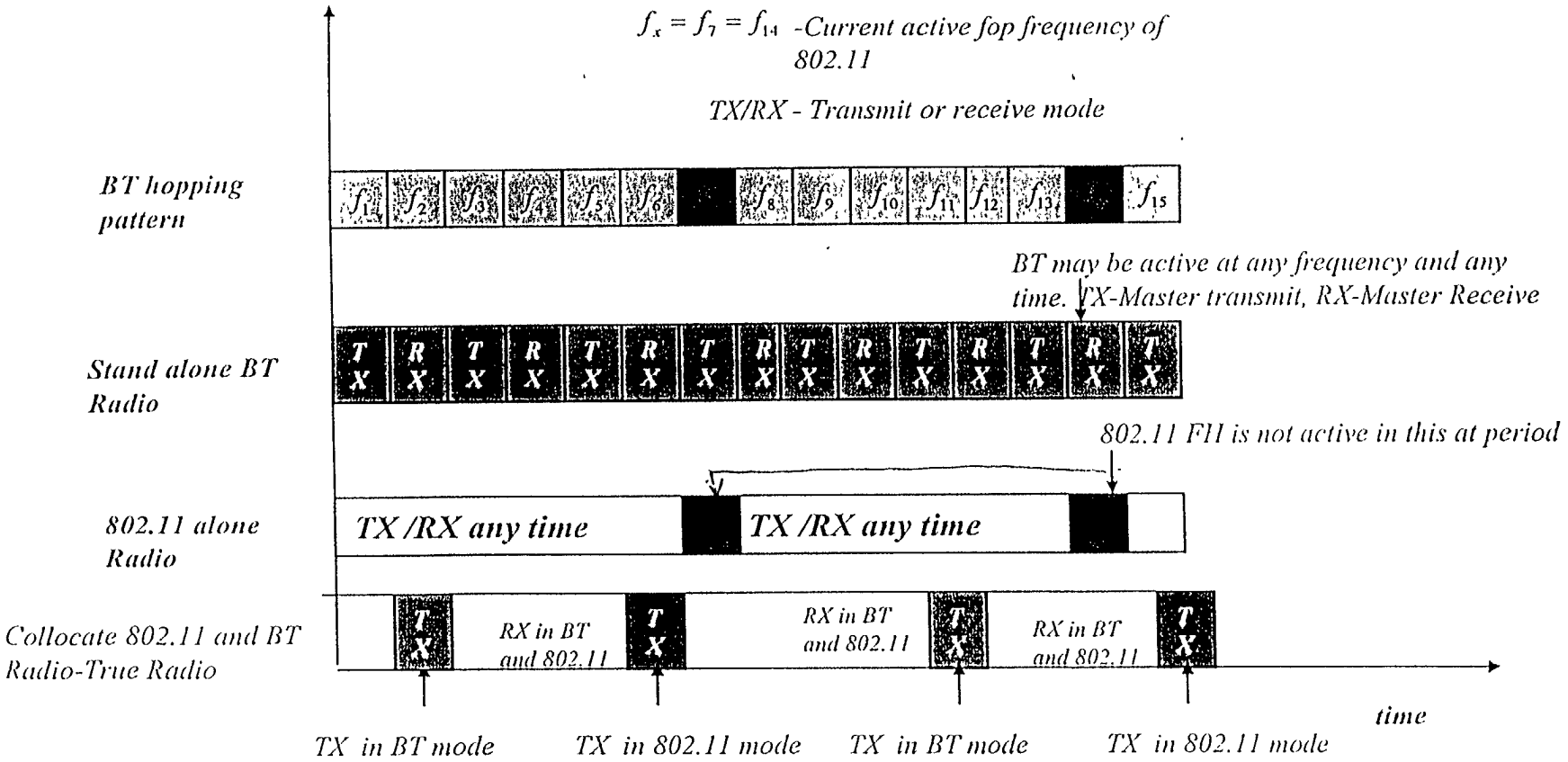

Fig. 8a

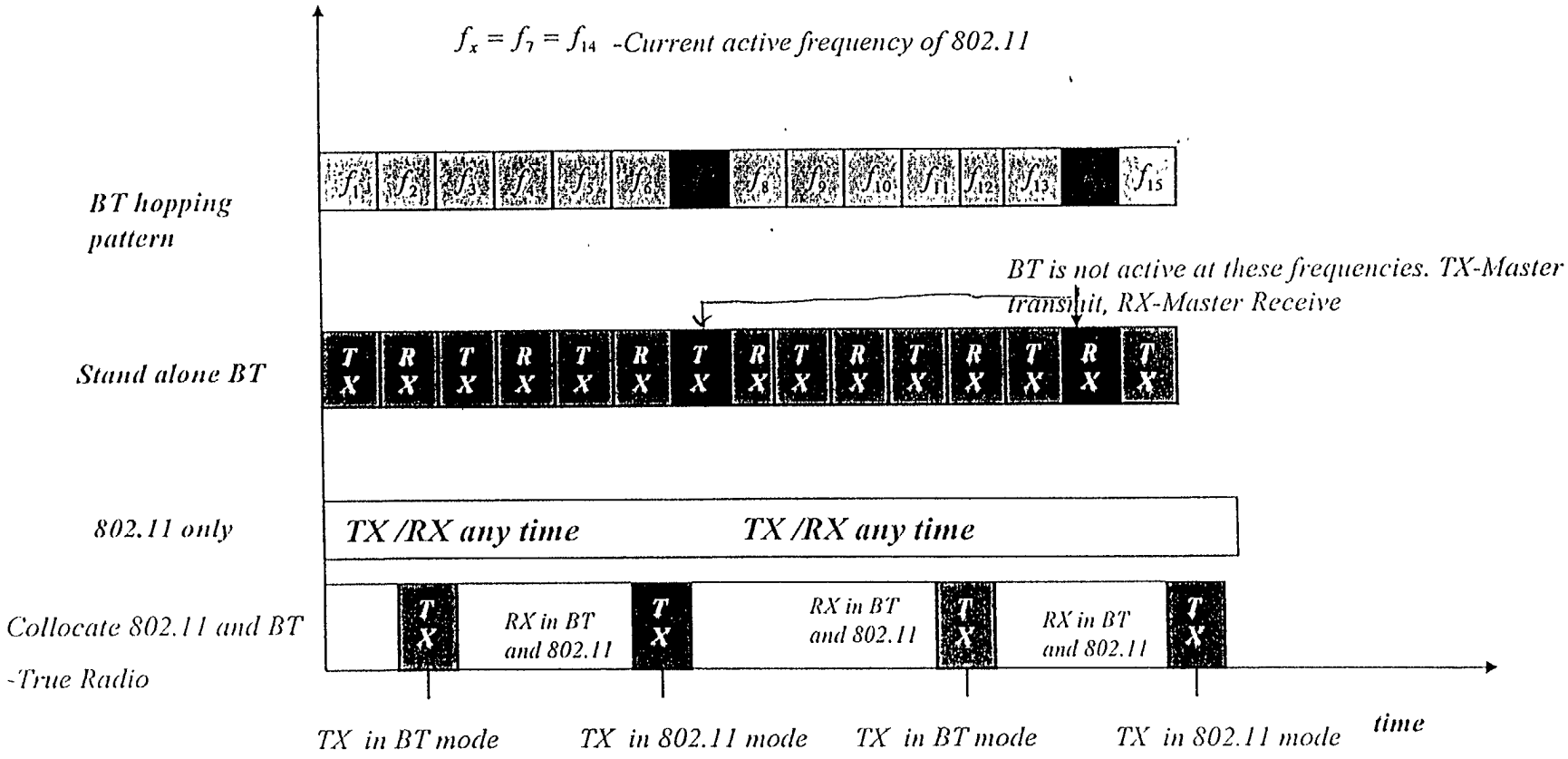
$f_x = f_7 = f_{14}$ -Current active frequency of 802.11
BT hopping pattern
BT is not active at these frequencies. TX-Master transmit, RX-Master Receive
Stand alone BT
802.11 only
TX /RX any time
TX /RX any time
Collocate 802.11 and BT
-True Radio
RX in BT and 802.11
RX in BT and 802.11
RX in BT and 802.11
TX in BT mode
TX in 802.11 mode
TX in BT mode
TX in 802.11 mode
time

FIG. 8b

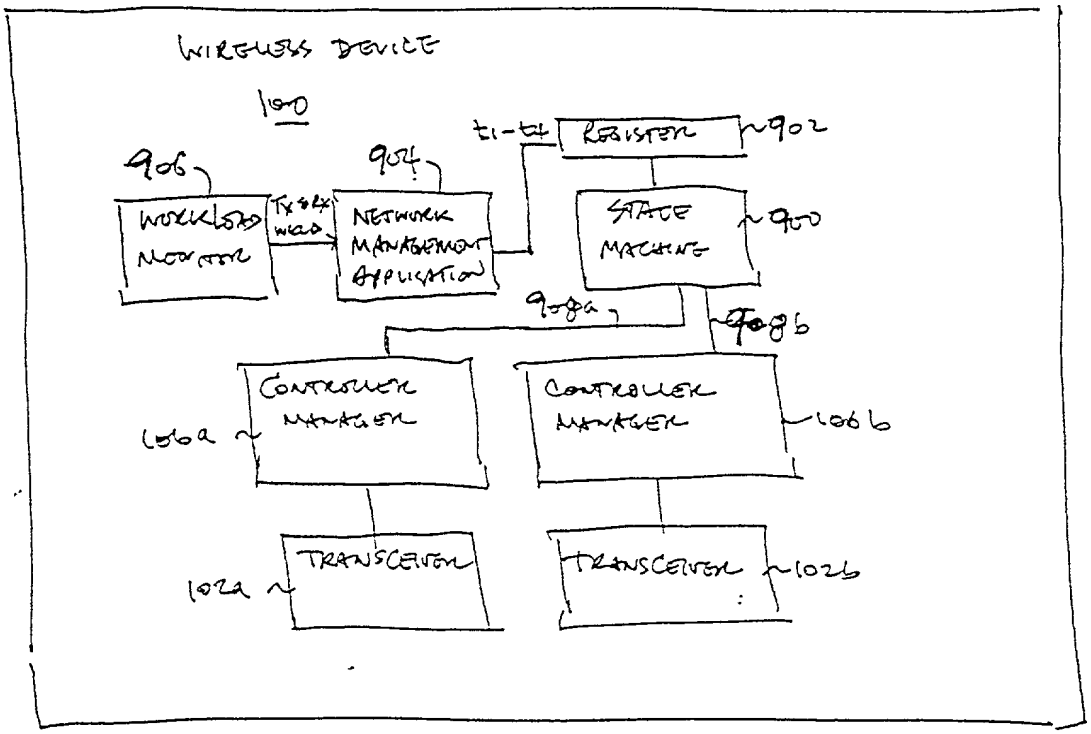
WIRELESS DEVICE
100
REGISTER
902
906
904
WORKLOAD MONITOR
TX & RX WLD
NETWORK MANAGEMENT APPLICATION
STATE MACHINE
900
908a
908b
CONTROLLER MANAGER
1066
CONTROLLER MANAGER
1066
TRANSCEIVER
1024
TRANSCEIVER
1026

Fig. 9a

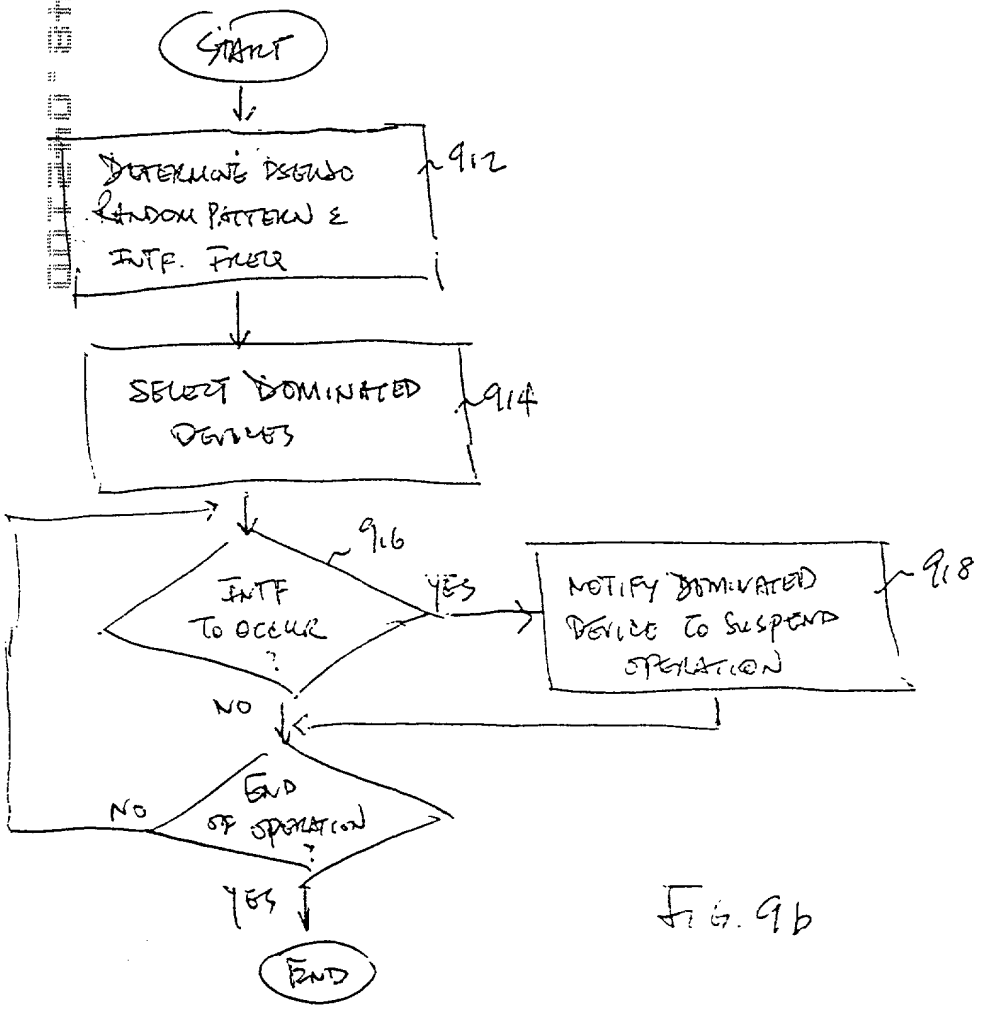
START
DETERMINE DSGNTD RANDOM PATTERN & INTF. FREQ
912
SELECT DOMINATED DEVICES
914
INTF TO OCCUR ?
916
YES
NOTIFY DOMINATED DEVICE TO SUSPEND OPERATION
918
NO
END OF OPERATION ?
NO
YES
END

Fig. 9b

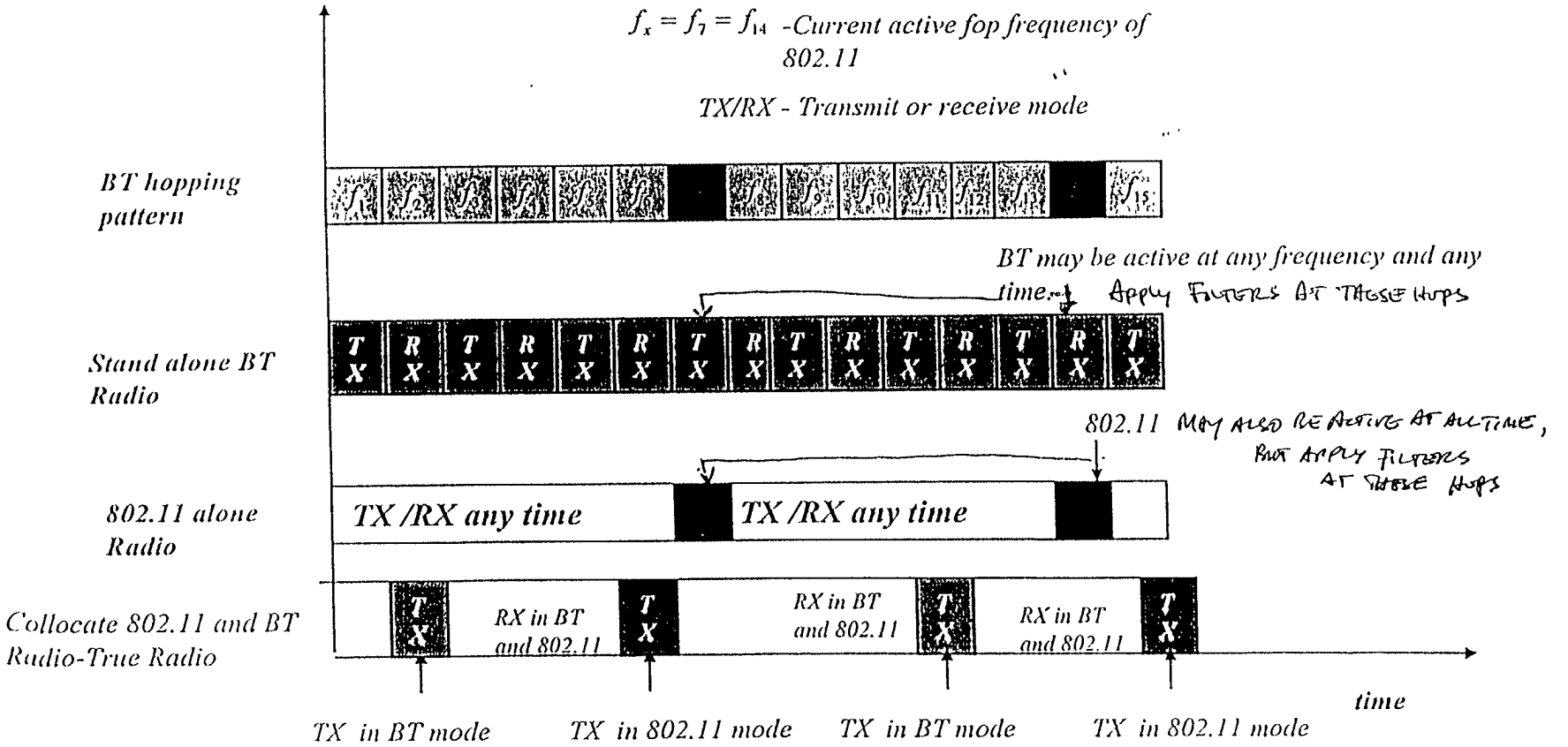
$f_x = f_7 = f_{14}$ -Current active fop frequency of 802.11
TX/RX - Transmit or receive mode
BT hopping pattern
BT may be active at any frequency and any time.
Apply Filters at those Hops
Stand alone BT Radio
802.11 may also be active at all time, but apply filters at those Hops
802.11 alone Radio
TX /RX any time
TX /RX any time
Collocate 802.11 and BT Radio-True Radio
RX in BT and 802.11
RX in BT and 802.11
RX in BT and 802.11
time
TX in BT mode
TX in 802.11 mode
TX in BT mode
TX in 802.11 mode

FIG. 10

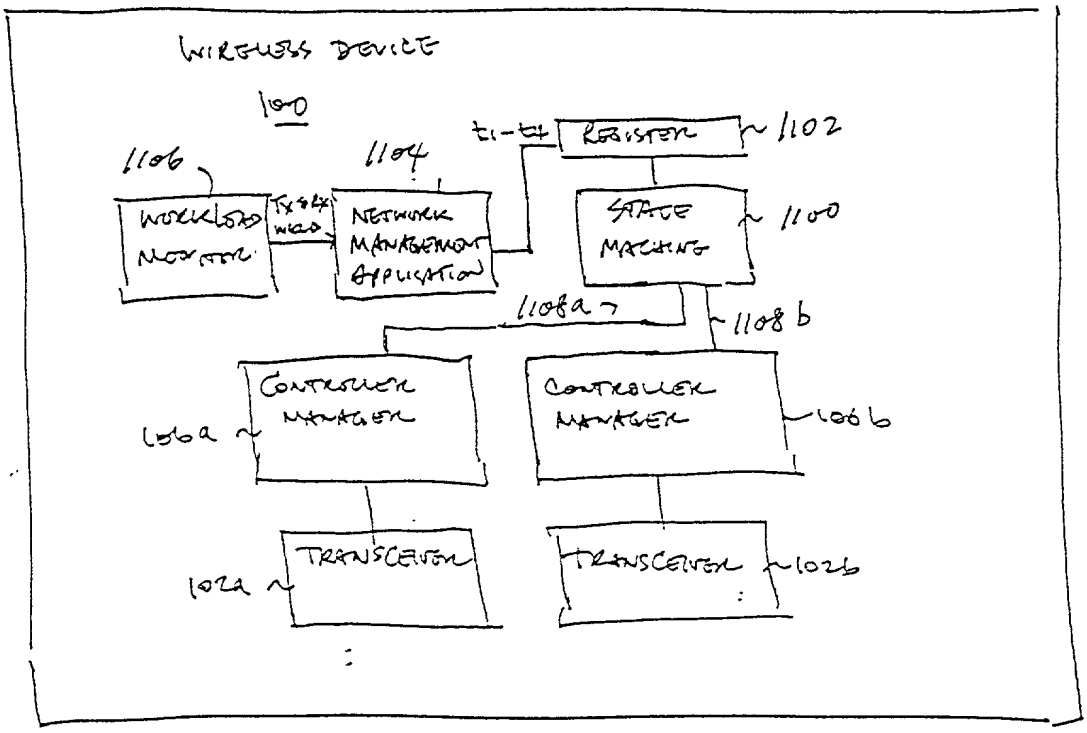

FIG. 11a

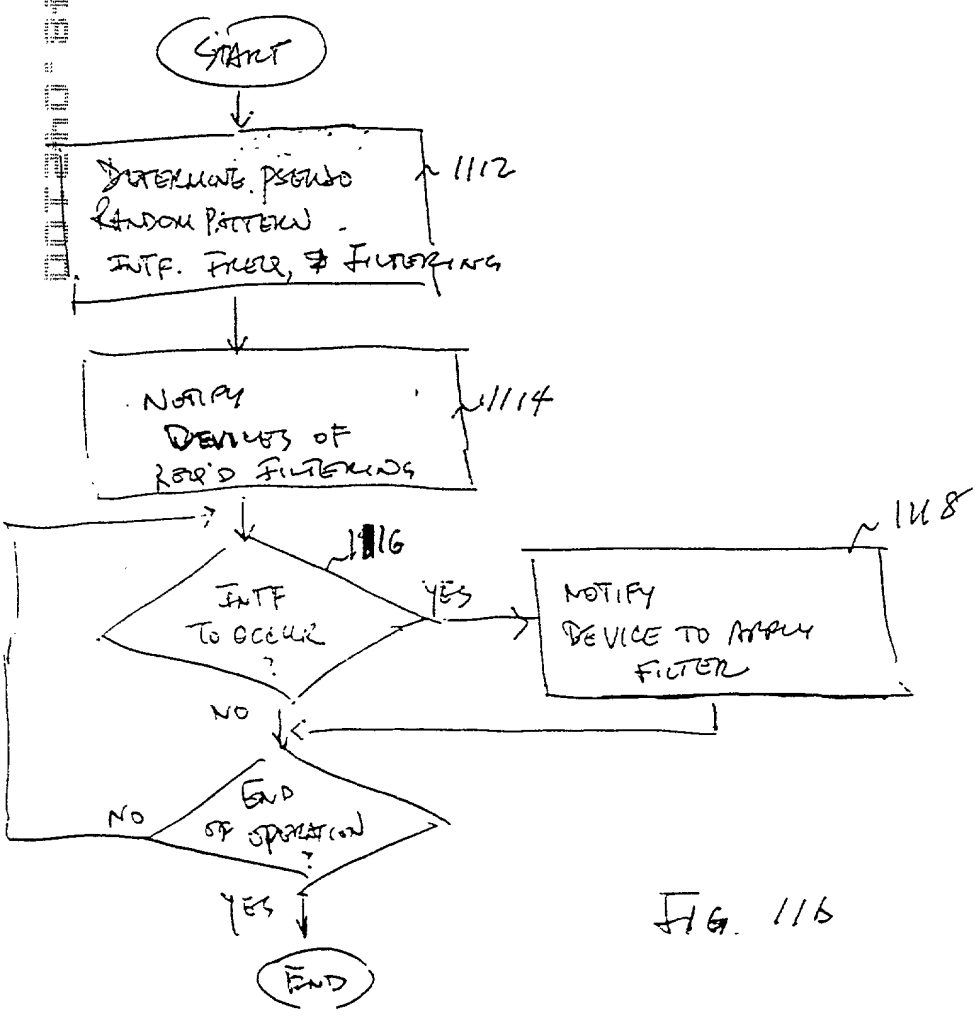

FIG. 11b

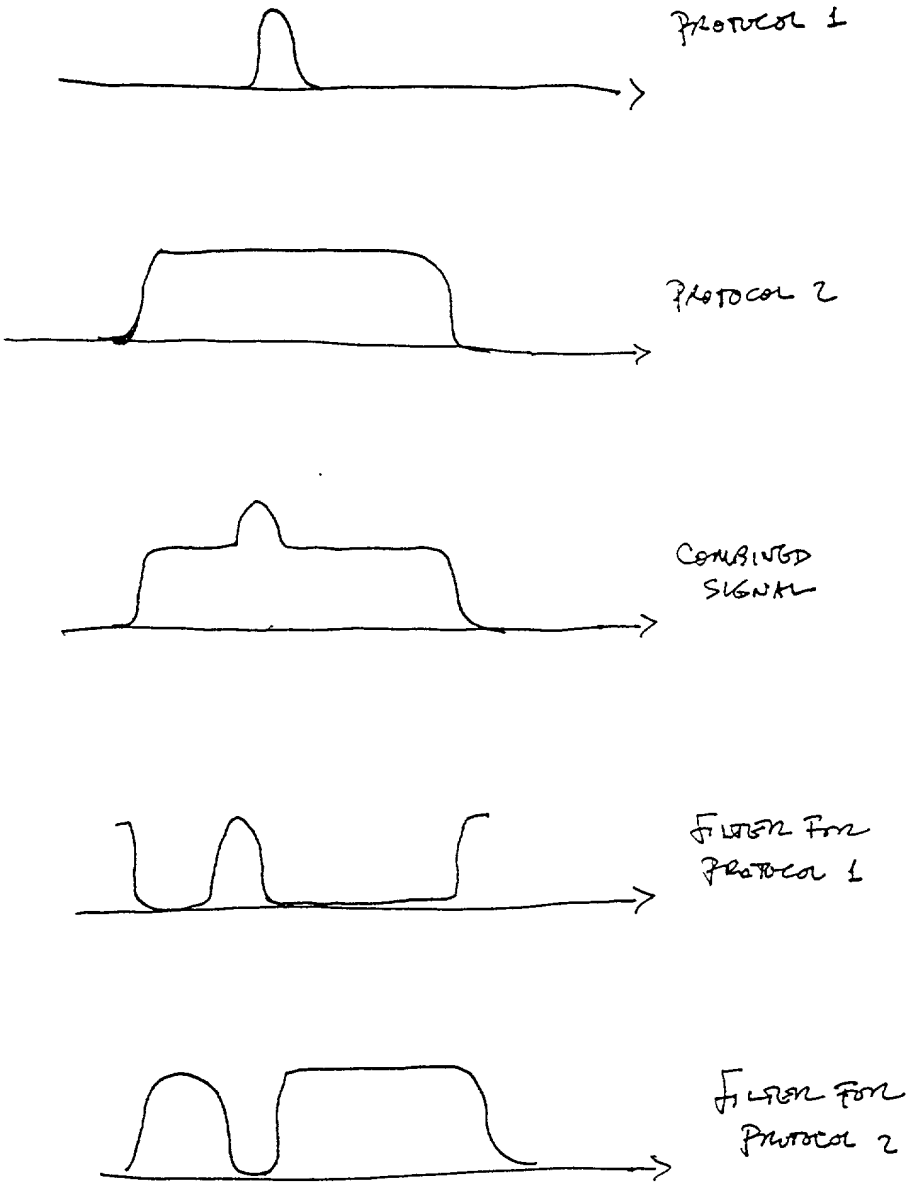
PROTOCOL 1
PROTOCOL 2
COMBINED SIGNAL
FILTER FOR PROTOCOL 1
FILTER FOR PROTOCOL 2

FIG. 12

MS Pat X

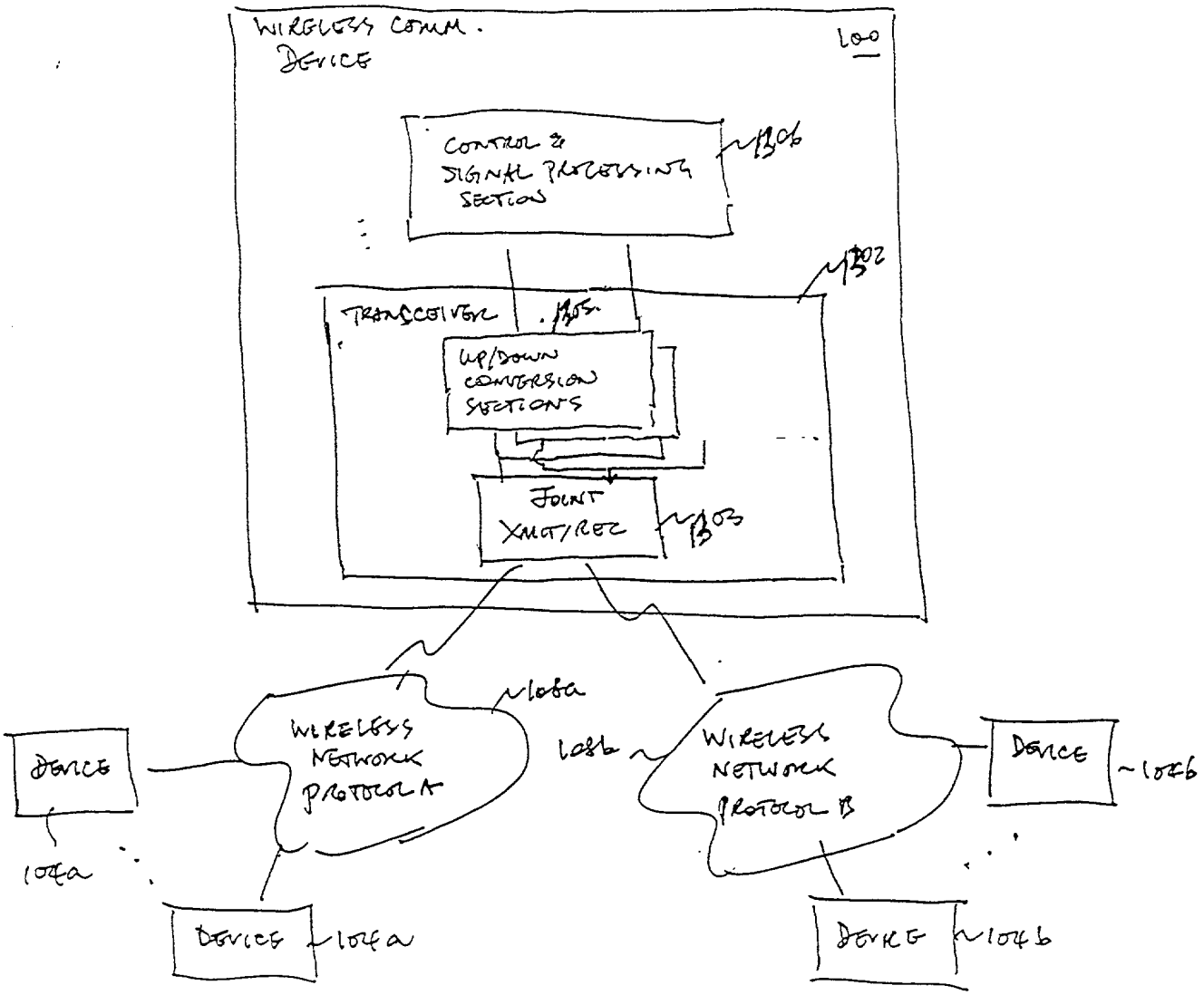

FIG. 1B

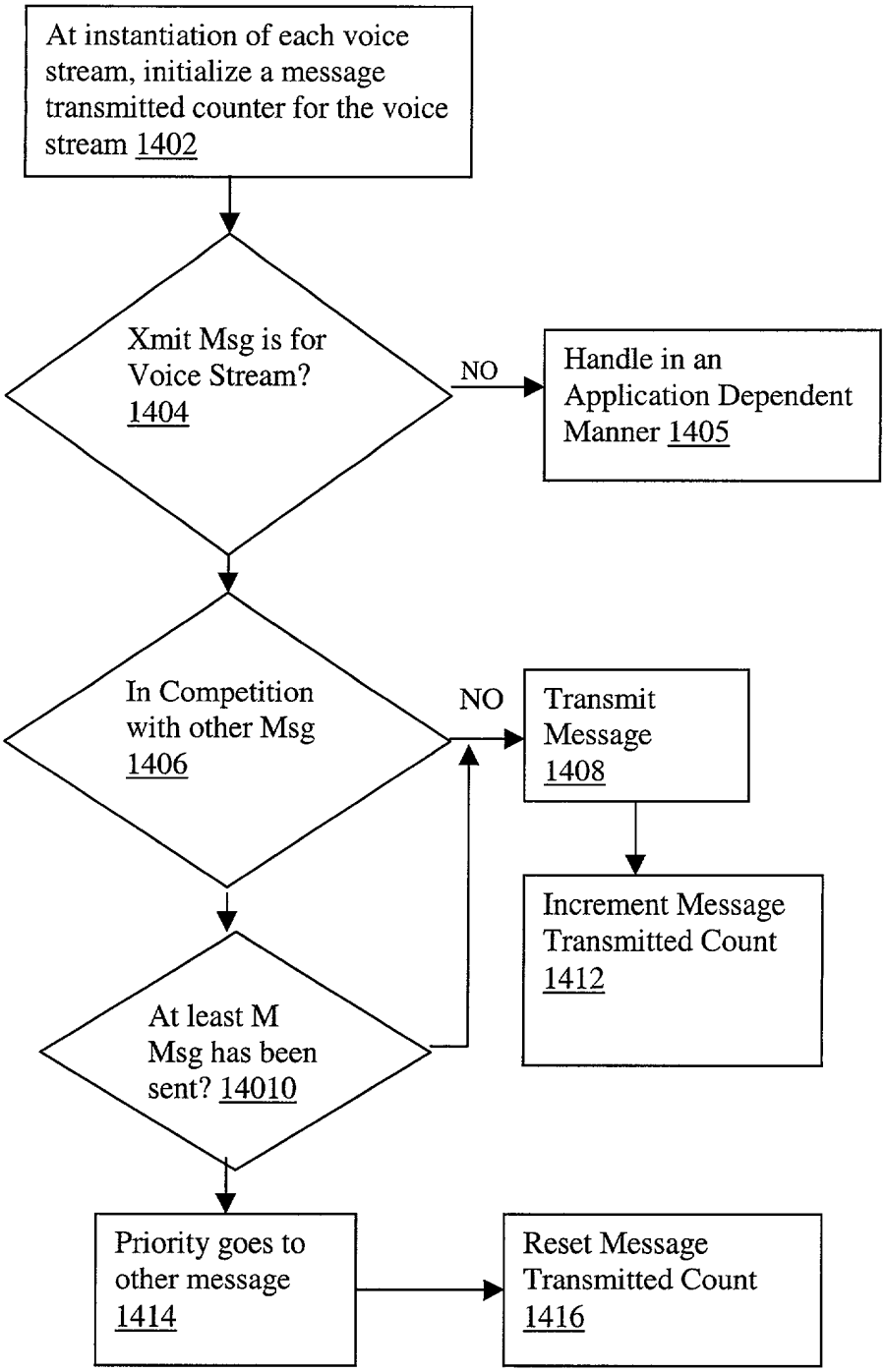
At instantiation of each voice stream, initialize a message transmitted counter for the voice stream 1402
Xmit Msg is for Voice Stream? 1404
NO
Handle in an Application Dependent Manner 1405
In Competition with other Msg 1406
NO
Transmit Message 1408
Increment Message Transmitted Count 1412
At least M Msg has been sent? 14010
Priority goes to other message 1414
Reset Message Transmitted Count 1416

Figure 14

Attorney's Docket No.: 04198.P011X PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MULTIPLE WIRELESS COMMUNICATION PROTOCOL METHODS AND APPARATUSES INCLUDING QUALITY OF SERVICE CONSIDERATIONS

the specification of which

X is attached hereto.
___ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number) Filing Date

(Application Number) Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph

of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

09/439,946 (Application Number)	11/12/2000 Filing Date	pending (Status -- patented, pending, abandoned)
09/408,725 (Application Number)	9/29/99 Filing Date	pending (Status -- patented, pending, abandoned)
09/436,458 (Application Number)	11/8/99 Filing Date	pending (Status -- patented, pending, abandoned)

I hereby appoint Farzad E. Amini, Reg. No. P42,261; Aloysius T. C. AuYeung, Reg. No. 35,432; Amy M. Armstrong, Reg. No. 42,265; William Thomas Babbitt, Reg. No. 39,591; Carol F. Barry, Reg. No. 41,600; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Yong S. Choi, Reg. No. P43,324; Thomas M. Coester, Reg. No. 39,637; Roland B. Cortes, Reg. No. 39,152; Barbara Bokanov Courtney, Reg. No. 42,442; Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Robert Andrew Diehl, Reg. No. 40,992; Tarek N. Fahmi, Reg. No. 41,402; James Y. Go, Reg. No. 40,621; Richard Leon Gregory, Jr., Reg. No. 42,607; Dinu Gruia, Reg. No. P42,996; David R. Halvorson, Reg. No. 33,395; Thomas A. Hassing, Reg. No. 36,159; Phuong-Quan Hoang, Reg. No. 41,839; Willmore F. Holbrow III, Reg. No. P41,845; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; William W. Kidd, Reg. No. 31,772; Michael J. Mallie, Reg. No. 36,591; Andre L. Marais, under 37 C.F.R. § 10.9(b); Paul A. Mendonsa, Reg. No. 42,879; Darren J. Milliken, Reg. 42,004; Chun M. Ng, Reg. No. 36,878; Thinh V. Nguyen, Reg. No. 42,034; Kimberley G. Nobles, Reg. No. 38,255; Michael A. Proksch, Reg. No. 43,021; Babak Redjaian, Reg. No. 42,096; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Anand Sethuraman, Reg. No. P43,351; Charles E. Shemwell, Reg. No. 40,171; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Judith A. Szepesi, Reg. No. 39,393; Vincent P. Tassinari, Reg. No. 42,179; Edwin H. Taylor, Reg. No. 25,129; George G. C. Tseng, Reg. No. 41,355; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Stephen Warhola, Reg. No. 43,237; Charles T. J. Weigell, Reg. No. 43,398; Steven D. Yates, Reg. No. 42,242; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys, and James A. Henry, Reg. No. 41,064; Daniel E. Ovanezian, Reg. No. 41,236; Glenn E. Von Tersch, Reg. No. 41,364;; and Chad R. Walsh, Reg. No. 43,235; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and James R. Thein, Reg. No. 31,710, my patent attorney; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Aloysius T.C. AuYeung (Name of Attorney or Agent), BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct telephone calls to Aloysius T.C. AuYeung (Name of Attorney or Agent), (503) 684-6200.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Ron Nevo

Inventor's Signature _____ Date 4/21/2000

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Full Name of Second/Joint Inventor Xudong Zhao

Inventor's Signature _____ Date 4/21/2000

Residence Portland, OR (City, State) Citizenship US (Country)

Post Office Address 16150 NW Andalusian Way
Portland, OR 97229

P05V0050 - 09/460,400

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.